The Future Role of 'Virtual' Design Teams

APPLIED VEHICLE TECHNOLOGY PANEL (AVT)
Keynote Session – Aerodynamic Design and Optimization of Flight Vehicles in a Concurrent Multi-Disciplinary Environment

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Summary: This keynote presentation will discuss the role that our aerospace engineers and their design teams and tools will play in the 'Virtual' design office of the future. Dramatically improving information technology is rapidly changing the design environment and the potential capability of the design toolsets. Along with these improvements in capability, there is a change in our expectations and requirements for both the design teams and the tools that enable the design teams to accomplish their tasks.

Today's Discussion: In this presentation we will describe the role of the 'Virtual' Design Team in a likely future design environment. We will take a quick look at the following influences and factors;

- **Design Environment Today**
- **Future Design Environment**
- **The 'Virtual' Design Team**
- **The Tool Requirements**
- **Snapshot of the Future**

This presentation will describe the quickly changing environment and consider how these changes may effect the future design office in which our design teams will be expected to perform. Lastly, what will the toolset needs and requirement be to support our design teams in the future design environment.

Today's Design Environment: Before discussing the future design environment, let's take a quick look at the design environment we are surrounded with today.

I will focus on a few key elements of today's environment centered around: How we pull our design teams together, how we handle our design information and knowledge, and some characteristics of our design toolsets.

For many years we have all seen the value of co-location of the project and design team. This is our preferred condition. We tend to rely predominately, if not entirely, on the co-located members of the design team and only reach outside this immediate group when absolutely necessary. As a result, we have the tendency to 'make do' with the group skills of the co-located team even when there are more experienced and better-qualified specialists within our companies.

We tend to rely on personal face-to-face contact both within our internal development team and externally with both our customer and supplier communities. We have all evolved a long list of interface, review, and follow-up meetings to ensure adequate communication during these design efforts. Sometimes we actually do provide good communication throughout a program's duration. But many times we fall short, and vow to incorporate yet an additional set of interface meetings in the next project we bring along.

Information is drawn into a design project from a wide range of sources. We draw from the company's history of similar and supporting projects through libraries of reports, data files, presentations, archives, and such. Each of the members of our design teams has personal experiences, files full of notes, collections of reference material and resources. We all have our phone lists of people who know a little more about some certain thing than we do. Or someone who knows someone who knows someone who does. Some of this database comes in the form of books and reports and pictures, some as computer files of text or modelling or algorithms, and much of it in hand-written notes and calculations or conversations or memories. Needless to say, much of the existing database is probably not in the appropriate form and format for the next analysis your design team performs or report they prepare.

Many of the toolsets used by our design teams originated, and are maintained, by the specialised functional disciplines that all contribute to the total system design process. There has been a strong push for many years to bring these various 'modules' together in a more integrated overall design toolset. We have all worked on this for a long time, and we still have a long way to go.

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Impact of The Information Age: A lot can be said about the 'Information Age' and the profound impact that it is having on each of our lives. For a moment let's consider some of the rapidly improving capabilities that both cause and enable a significant change in the way our design teams will do their job is the near future.

New and rapidly improving capabilities include;

- **Immediate Access to Information**
- **'Paperless' Information**
- **Continuous Communication**
- **Telecommuting**
- **Electronic Assistance & Automation**
- **Increased Computing Speed & Capacity**
- **Electronic Media**

The 'Virtual Office' has become something we are all a part of in one way or another. There has been one shortfall up to now in the Virtual Office's ability to support high technology design teams. As the products we design have become more highly integrated, complicated, and sophisticated; the design tools and design databases have become electronically huge. The dramatically improving capability to rapidly, and in 'real-time', transfer huge amounts of electronic data to anywhere in the world, is now enabling design teams to be 'virtually' co-located while actually being geographically distributed. The 'Virtual Office' can now become the 'Virtual Design Office'.

The Future Design Environment: There is an almost endless number of things that will be a part of the future environment that will influence our design teams. Let's consider four key elements that will have a high level of impact to the design teams;

- **Geographically Distributed Teams**
- **Highly Diversified Teams**
- **Common Information & Database**
- **Common Processes & Toolsets**

At Boeing we are calling the distributed total 'enterprise' team capability - **"Design Anywhere, Build Anywhere"**. Organizational, Processes, Infrastructure, and Cultural changes are beginning to reflect this move into the future environment.

Future Design Teams must include a highly diverse technical skill group to address increasingly complex and highly integrated design challenges. The teams will have both company internal and company external participants that address all phases of the air vehicle's lifecycle from design and development, through manufacturing and operational support.

'Real time' communication of all forms of data and information will tie the design teammembers together as a cohesive unit. The large amounts of project related data and information will be quickly accessed from many legacy sources, will be traceable and controllable, and will be in directly usable forms and formats.

A design toolset built of common processes using a common database will provide effective and efficient utilization of all teammembers and design information. Analysis 'modules' using common geometry models and data formats will minimize wasteful reconstruction of unique databases. Having common databases also greatly simplifies all aspects of configuration control. Commonality will reduce the development, maintenance, and training costs associated with multiple unique processes and tools.

Broadening Customer Base & Marketplace: The industry has moved toward more consolidation over the past several years. Individual company's traditional customers and marketplaces, no matter what they were in the past, have expanded and now encompass a much wider industry perspective.

There are elements of both government and commercial, domestic and international in most companies' business base. This has created multiple customer interfaces, interactions, business relationships, and 'shared destiny' from what may have been a very focused 'company/customer' view in the past.

Future Design Process & Tools Requirements: Increasing focus on "affordable" aerospace vehicles demands wide ranging improvements in processes and integrated toolsets. Tool requirements will focusing on efficient utilization several key company resources: People, Time, and Knowledge base.

We must leverage the best people and their skills from across the entire company 'enterprise' regardless of where they live and work. This will drive us into the 'Virtual Design Office'.

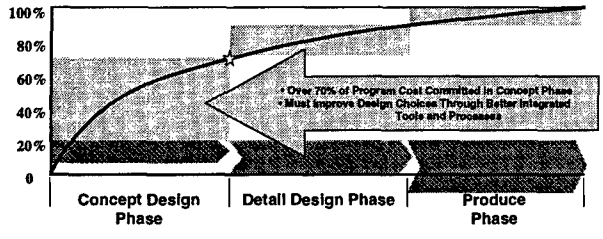
We must effectively apply our 'enterprise' wide knowledge base of information, processes, and tools against the always more challenging design efforts.

To reduce the total investment of resources, we must shorten the time required to effectively study design options and make critical decisions. This also means we must provide improved design fidelity across a wider range of design options earlier in the design cycle.

The companies that achieve aggressive goals for improvement will have a strategic business advantage over their competitors.

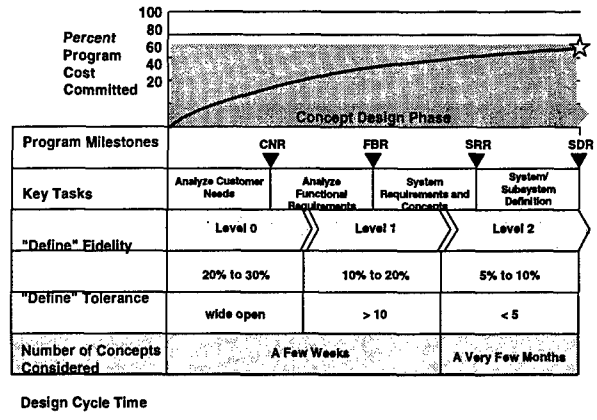
Improved Decision Making in Early Phases: Lets step back and look at what is driving the design cycle time needs.

Program Cost Is Committed Early
We Must Provide Data to Support Decisions

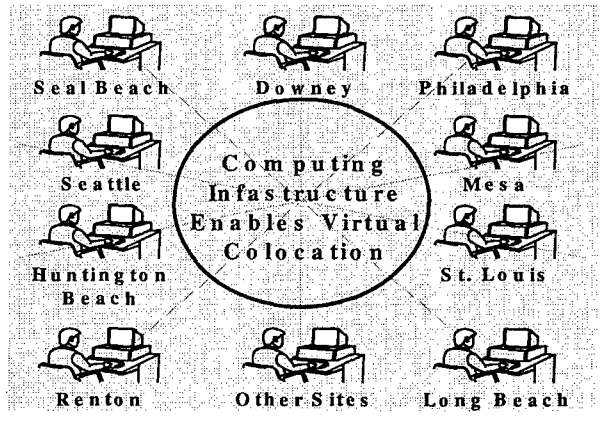


The majority of the cost of a program is determined in the very early phases of design. Because of this, it is important for us to make critical decisions early in the design process. And it becomes very important for us to improve the fidelity of design data as early as possible. Highly integrated design tools and improved processes are required to reduce cycle time while at the same time improving design choices, design fidelity and knowledge based decision making capability.

A Closer Look at the Concept Design Phase: The Conceptual Design phase moves through several different design cycle characteristics. These range from very rapid assessment of a very wide range of possibilities in the initial efforts, to a more focused and detailed analysis of the "best" design solutions later in the effort. The design solution needs and requirements evolve during this design phase. The needed design 'fidelity', to conduct early decisions of design solution screening and selection, initially requires less stringent design tolerance.

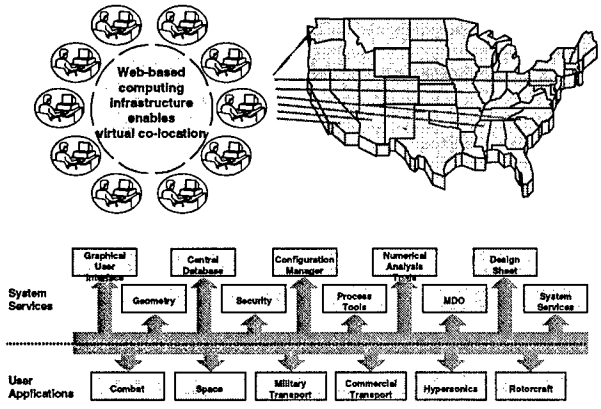


'Virtual' Design Office - Accommodating Distributed Teams: Computing infrastructures are evolving to support 'Virtual' co-location of high technology design teams.



Web-based communication technology provides quick access to and transfer of the huge amounts of technical data design teams require.

Web-Based Computing Infrastructure: The new communication and computing infrastructure effectively ties the service providers (design toolsets , 'enterprise' technical experts, databases, and toolset developers & maintainers) directly together with the user groups (design teams) in 'real-time'.



The ultimate success of 'Virtual' co-location and the 'Virtual' Design Team depends on this capability.

Design Practices, Processes and Tools Integrated Into One Common Design Environment: We will continue to address the evolving needs and requirements through new approaches and implementations of improvements to our tools and processes. The goal is to provide strategic competitive advantage for the company and to provide significant benefit to the customer through improved products and services.

- **Evolving Needs and Requirements**
- **New Approaches and Goals**
- **Benefit to the Customer**

A Day in the Life of "The 'Virtual' Design Team":

Lets imagine we are on that 'Virtual' Design Team in the near future. The day starts off with our daily 'stand-up' team meeting. Several teammembers are in each of three conference rooms hundreds of miles apart. Others are on their personal computers in even more locations. The 'virtual' meeting participants include teammembers from the company, several suppliers, and the customer. There is a design integration issue between the structures designers, the sub-systems installation designer, and two hardware supplier engineers. A decision is made to ask for help from an experienced consultant. Arrangements are made and that team-segments 'virtually' meets later in the day to work the details of the design problem. During that meeting, the current design is viewed in 3D and the lead designer describes the issues. Many questions are asked and different teammembers take control of the '3D visualization' to understand all the design implications and offer potential solutions. Someone remembers a similar design issue from a previous project, they quickly recall it from the 'enterprise' library archives and show it to the rest of the group. The group identifies several potential options, the customer describes his concerns for support when in service, and the options are narrowed. The group discussed what analysis and supporting data must be generated to make the final decision, and the team agrees on a time to reconvene later in the week to review the results and make a decision.

Meanwhile, the manufacturing engineer, working with the Research group thinks that a new bonding process may eliminate several expensive assembly steps during production. He calls the vehicle design integration leader and they review the research results from their own work areas. A manufacturing assembly simulation using the common 3D design database is ready the next day to assess the affordability improvement of the new process. The integration leader convenes a 'virtual' meeting of the design area affected and ensures . . .

. . . And then we win that next contract, launch that next aircraft program, or design that next prototype. Sounds great doesn't it?

What Toolset Developers Need to Consider: As the 'Virtual' Design Office of the future drives and establishes needs for improving capabilities, both the design teams and tool developers will have to address many new implications:

- **Tools and Processes Must Support the 'Virtual Office' Environment**
- **Tools Must Provide Increased Fidelity Earlier in the Design Effort**
- **Consideration of Greater Number of Ideas**
- **Must Support 'Real Time' Data Links**
- **Common Data Formatting And/or Compatibility**
- **Tools Must be Transparent to All User 'Platforms'**

Above all, there is one important question we must always keep asking ourselves:

Are the Tools We Are Developing Going to Support the Future Environment ?